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A STUDY OF THE
OPERATING ROOM SCHEDULING
SYSTEM AT TRIPLER ARMY
MEDICAL CENTER, HAWAII

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A Problem Solving Project
Submitted to the Faculty of
Baylor University
In Partial Fulfillment of the
Requirements for the Degree
of
Master of Hospital Administration

By

Captain Charles F. Fehring, MSC

August 1981

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I. INTRODUCTION

Development of the Problem

Convinced that the operating rooms were being scheduled in somewhat less than an efficient manner, the Chief of Anesthesiology and Operative Service at Tripler Army Medical Center requested that the scheduling system be studied. Also, cognizant of problems with scheduling the operating rooms, the Chief of the Department of Surgery at Tripler agreed that assistance was needed and fully endorsed this study.

2, Tripler has an eight room operating theatre which averages over 560 cases per month. Generally, seven rooms are utilized daily with operations scheduled from 0700 to 1430 hours five days a week. The eighth room was reserved for emergencies. Lately, however, this room has also been scheduled for routine cases because the increasing number of surgeons and limited operating room time are making it difficult for each surgeon to perform enough surgery to qualify for board certification. However, using all eight rooms for routine cases poses a serious problem when an emergency occurs.

Appendix K
1 Says 160 per week
160 x 4 = 640

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NTIS CRAM	✓
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Justification	
By	
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In an effort to measure scheduling efficiently, Tripler has recently instituted a block booking method of scheduling surgery. This means that surgical specialties are assigned blocks of time on certain days during which they may schedule their cases. The blocks change each day. For example, a typical one-day schedule might have two rooms for orthopedics, one for neurosurgery, one for gynecology, two for general surgery, and one half of a room each for gynecology and otolaryngology. Each of these two specialties would only have about $3\frac{1}{2}$ hours of operating room time on this particular day. Some of the specialties might not have any more time blocked for several days, while others will have no more time during that week. The Chief, Department of Surgery determines how much time is blocked for each specialty based upon his own statistical analysis and stated demands from the various service chiefs.

The real problem lies not so much with the blocking of times as it does with how procedures are scheduled within those blocks of times. While improvements also need to be made in allocating blocks of time, the major effort must be in improving the actual scheduling of procedures. A system that could do both would be

that much more beneficial. .

The scheduling of surgical cases within the blocks of time is done on a daily basis by a staff anesthesiologist in conjunction with the physicians from the various services who have patients requiring surgery. The actual time allotted for each case is calculated by a "best guess" method. The "guess" is made by the anesthesiologist and it is based upon the type of procedure to be performed and the estimated time it will take that particular surgeon to perform it. Should any or all of these components of the system (the anesthesiologist, the surgeon, the procedure) be new to Tripler, the inaccuracy of the "guess" increases markedly. Many times the physician requesting the surgery and the anesthesiologist scheduling the surgery disagree on the time estimates. Much negotiation must then ensue prior to finalizing the scheduling of these procedures. The inaccuracies inherent in such a system afford the opportunity for under- or over-scheduling the operating rooms.

This system has resulted in no end of frustration for the medical staff. Surgeons are having to wait beyond their scheduled operating times or having cases cancelled because of inaccurate time estimates.

In other instances, operating rooms sit idle also as a result of poor time estimates. Surgeons are concerned about the number of cases they must do in order to become certified and department chiefs are concerned about the lack of operating room time their departments have and the resultant adverse impact on the various teaching programs.

For the reasons cited in the above discussion, assistance was requested in order to alleviate the scheduling problems.

Problem Statement

The problem was to determine the best system for scheduling operating room usage at Tripler Army Medical Center, Hawaii.

Limitations

One of the major limitations of this project was the availability of data. It proved to be more of a limiting factor than originally had been anticipated. It turned out that the data with regard to anesthesia and procedure times on the Register of Operations (DA Form 4108) was not accurate. This form is maintained for ten years, and was to have been the major source of

Why? In Appendix
K. Para 7 says
DA 4108 will be
used. If it is
not accurate,
why is it
being used in
the proposed
new system?

why?

empirical research data. Instead, the Operation Request and Worksheet (DA Form 4107) had to be used.

Unfortunately, there is no requirement or need to save this form beyond three or four days after surgery has been performed. Therefore, the DA Form 4107 has been saved only since October 1980, when this project was initiated. Rather than having ³three years of data to analyze, there turned out to be only three to five months' worth of accurate data available. For some procedures this proved to be sufficient, but for many it was not.

It will be shown later that this lack of data has not invalidated this study or the scheduling project; it has merely limited what could be done with the data for the purposes of this particular paper.

In conjunction with the unavailability of data, another limitation involved computing procedure times by physician. The same three to five months' worth of data was available for this purpose. The limiting factor was the large number of physicians performing the procedures.

For example, in General Surgery Service accurate data might have been available on forty-five

The lack of 3 yrs worth of data is significant because your PSP proposal talked about a "trend analysis" based on 3 yrs worth of data. See Page 5-6, PSP.

appendectomies. But, fifteen surgeons would each have performed three of them. Therefore, while procedure times for each physician were calculated in the course of the research, they are not included in this study. The judgment was made that there was insufficient data to make displaying physician procedure times meaningful at this time.

Another limitation encountered involved the types of procedures. During the research, it was discovered that some highly specialized procedures were performed very infrequently, while other procedures were performed with several variations. Rather than record times for procedures that are only performed once a month, it was decided to limit data collecting to the most commonly performed procedures. The staff anesthesiologists selected the procedures analyzed in this study as representing about 80 percent of the total amount of surgery performed at Tripler. Thus, not every surgical procedure performed at Tripler appears in this study.

Yet another limitation was the lack of formalized scheduling systems at civilian hospitals in the community. While the hospitals contacted had certain procedures which they followed in scheduling

*Again a
significant
departure from
your original
PSP, see P 5.*

Documented?

their operating rooms, none were found to be any more effective than the one currently being used at Tripler. Nothing in the way of innovative or unique procedures could be gleaned from the local hospitals in the area of operating room scheduling.

*OK. Documented
in original PSI*

Criteria

Other Factors Influencing the Solution

Any solution to the scheduling problem must insure that the teaching mission at Tripler is considered, specifically, the teaching programs involving requirements to perform surgery. Surgeons are required to perform a certain number of cases of surgery in order to be eligible for board certification. Any solution to the operating room scheduling problem cannot interfere with this requirement so as to diminish the time available to each surgeon to perform episodes of surgery. Rather, the solution should increase available operating time for the surgeons.

*Not in
original PSH.*

Another factor influencing the recommended solution is the establishment of certain criteria which the solution must meet. The criteria for the solution have been developed by the staff members most closely associated with the problem. They are:

Colonel Paul L. Shetler, M.D., Chief, Department of

Surgery, Tripler Army Medical Center; Major Larry T. Bourke, M.D., Chief, Anesthesia and Operative Service, Tripler Army Medical Center; and Major Linda K. Weir, M.D., Staff Anesthesiologist, Tripler Army Medical Center.

It is essential that any solution to the current problem minimize the amount of unused (idle) operating room time. While it would be attractive to eliminate idle time, it is not really feasible, due to the human aspects of surgery. However, having operating rooms left unused for one or more hours because of bad guessing in negotiating the schedule is a problem that any solution must resolve.

Another criterion for judging the viability of the solution is that it must provide a method for equitably distributing operating room time among the various services. In other words, improve the distribution of blocked time.

The solution must also facilitate scheduling by establishing a basis for allocating procedure and physician utilization times. At the same time, it must also eliminate, to the extent possible, the guessing and negotiating by which operating room time is currently scheduled.

An additional criterion is that the solution must maximize the number of cases that can be done during the allotted time on any given day. This is to be done

Job shop
scheduling

criteria
for selection
approved
in original
PSP.

without diminishing the quality of patient care. The idea here is to schedule as much surgery as possible each day without giving the appearance, real or imagined, of practicing "assembly line" medicine.

It is also desirable that the solution make possible the conduction of retrospective anesthesia investigations and to accommodate the collection of anesthesia data, such as anesthesia drugs and equipment used, special procedures performed, and any complications.

It is conceded that these criteria are subjective in nature and not readily measurable. No standard has been developed which states how many cases should be performed each day in order to maximize utilization of the operating rooms. Likewise, there is no standard which reflects how much idle time is acceptable in the operating theatre under a system which has as its goal minimizing it.

The ultimate determination of whether or not the recommended solution meets these subjective criteria must be left up to the professional judgment and experience of the Chief, Department of Surgery and the anesthesiologists once the recommended solution has been implemented.

*I thought
criteria were used
to help a mgr evaluate
recommended alternatives
if the validity will be
determined after the fact
what criteria are you
using to make your
recommendation?*

*Statistical Data
might be useful
in determining
the best
SOLUTION
The original
PSP made
some mention
of this.
However, it
is agreed
any info
only a "to
a mgr
in decision
making*

Another factor which will influence the recommended solution is the assumption that physicians perform similar procedures in a similar manner. It must be assumed that the time it takes physicians to conduct an episode of surgery varies because of personal style and idiosyncracies, and not because of major procedural differences. In other words, if it takes one physician sixty minutes to perform an appendectomy and another seventy-five, the variation is due to individual style and not the basic technique used. Making this assumption means that physicians could be expected to change their styles in order to achieve the average procedure time. Whereas, if their times were due to the method used, this could not be the case, and the data collected would be of little value in predicting procedure times.

Literature Review

The problem of operating room scheduling has long been recognized as a critical one in the health care field, and one that has seen a host of attempts at resolving it.

Grumbles et al. concede that operating room scheduling is one of the most difficult administrative tasks that a modern hospital must face, and proposed

using a combination of a master posting sheet and a scheduling sheet.¹ This method required that cases be shuffled around in the event surgeons ran over schedule, and had no provisions for making valid time estimates.

Prior to this, a two-room system was espoused by Kildea.² This method has one surgeon scheduled in two operating rooms, and while he is operating on one patient his other one is being prepped in the next room. While it may improve operating room scheduling, the author admits that it is not for every hospital, especially ones with a limited number of rooms.³

Yet another effort in resolving scheduling problems was espoused by Francis in his article dealing with a card and carousel system.⁴ This system logs all pertinent information on cards which are placed in a carousel for easy access. While easier to read and reference, this system merely replaces the old posting book system.

Other attempts to facilitate scheduling have included a graphic system of operating room utilization⁵ and using time and motion studies to assist in determining daily usage of the operating room.⁶ Neither of these has met with more than a modicum of success,

although they did assist with easing that particular hospital's problem at that particular time.

Goldman et al. discussed using a computer simulation model to assist in resolving scheduling problems.⁷ This study demonstrated that longest cases should be scheduled first, as it proved to be superior under the simulation model.⁸ However, it did little else with regard to developing a system that could be utilized in other hospitals.

Block booking, still a fairly popular method of scheduling, was described by Morgan as another means to deal with scheduling problems.⁹ This particular process also incorporates the two-room system described earlier, and the author admits that this particular system is best suited to hospitals with an ample number of operating rooms.¹⁰

All of the previously discussed systems are manual, and none of them provide for any type of mechanical assistance in scheduling. A further review of literature indicates that much is being written in favor of data analysis and use of the computer in scheduling operating rooms, while, at the same time, criticizing manual methods of scheduling.

Ernst et al. point out that manual scheduling of the operating room frequently leads to a schedule that is criticized or inefficient and unfair while often creating discord among the staff.¹¹ Further castigating a manual method like Tripler's, Priest states that, at his hospital, scheduling deteriorated to the point where procedure times were based on the operating room secretary's recollections.¹²

Developing a formalized scheduling system, based upon an analysis of historical data would lead to much more realistic utilization of the operating rooms and reduce incidents in which the surgeon is delayed or asked to begin earlier than expected.¹³ This system, particularly a computerized one, could recall procedures, surgery time, anesthesia time, and operating room utilization statistics as required.¹⁴ Cresto and Devor also suggest that anesthesia data, such as methods and agents, could be captured and recalled by the same system.¹⁵ This possibility is echoed by Shaffer et al., who discuss using the computer to summarize cases handled, the anesthesia techniques and agents, and complications.¹⁶ They also talk about the need to statistically evaluate operating room utilization in order to obtain the proper

scheduling of cases and to decrease delay times between cases.¹⁷

With regard to the proposed statistical analysis, Priest supports calculating the means and the standard error of the means for both the surgeon's time and the procedure time in order to prepare the operating room schedule.¹⁸ This method would provide an average procedure time per surgeon, as well as an average time for each procedure. This latter piece of information would become essential for scheduling surgeons who have no prior record of performing that particular procedure at Tripler.

While a computer scheduling system would indicate how long surgeons take per procedure, Bendix et al. warn of a potential problem. Physicians may resent being shown that they take more time than some others for the same procedure, and may even challenge the statistical computations about their performance.¹⁹ However, with an appropriate demonstration of the system's usefulness, physician objectives can be overcome and a realistic, "personalized" scheduling system can be implemented.²⁰

The literature is quite supportive of the need for an efficient and effective operating room scheduling system. The problem, the needs, and the outcomes discussed in the literature are very pertinent to Tripler. Designing a scheduling system, particularly a computerized one, may not only solve Tripler's problems, but also lead to a more innovative and imaginative approach to operating room management.

Problem-Solving Methodology

Data collection for this project was designed to provide a meaningful assessment of anesthesia and procedure times in order to develop a workable solution to the operating room scheduling problem. The source document turned out to be the Operation Request and Worksheet (DA Form 4107). Data extracted from this form included: Beginning and ending anesthesia times, beginning and ending procedure times, the type of procedure performed, and the name of the surgeon. In addition, the chiefs of the services who utilize the operating theatre were requested to provide their estimated procedure times for their most common procedures.

During the course of the research, it was discovered that clean-up and set-up times were a

Why was this done? The original PSP said the "calculated times" would be compared w/ actual over a 2 mo period. What happened?

uniform fifteen or thirty minutes depending upon the type of case being performed, and an analysis of these was considered to be unnecessary. The research also uncovered the fact that insufficient data was available to accomplish any meaningful analysis beyond that presented in this study.

Cont 2

Once the data was collated, means and standard deviations were calculated for both anesthesia and procedure times. The anesthesia time begins when the patient enters the operating room and ends when the patient leaves. The procedure time begins when the surgeon places the scalpel to the skin and ends when the surgeon completes the final suture. The standard error of the mean for each procedure time was also calculated. In addition, the average times each service chief estimates it takes to perform certain procedures were compiled.

In order to compare scheduling systems, visits and interviews were conducted at the Queen's Medical Center, St. Francis Hospital, and Straub Clinic and Hospital. These three hospitals are all in Honolulu and constitute about 900 of the city's total hospital beds. The people in charge of scheduling the operating rooms were interviewed at all three hospitals.

It was determined that there are three realistic alternatives to the resolution of this problem. The first one is to maintain the status quo and wait for the new addition to be completed, hoping that a new operating theatre will cause the problem to resolve itself. The advantage of this alternative is that everyone is accustomed to it and it does work to the extent that surgery does get performed. The operating rooms are fully scheduled everyday and no surgeon has as yet failed to perform enough surgery to become board certified.

This alternative also brings with it its current problems. The opportunities for incorrectly scheduling and wasting operating time are numerous. The increasing number of surgeons means an increasing need for more operating time if board certification is to be achieved. It lacks any real means of equitably distributing operating time among the services. And, as the literature suggests, it brings with it the inefficiencies inherent in any manual system not supported by data analysis or mechanical methods.

The second alternative is to maintain the present system, but improve it with a manually prepared

statistical analysis, like that appearing in this project. By capturing and analyzing anesthesia and procedure times, there would be a solid statistical base upon which to depend for more accurate scheduling. More accurate scheduling would mean improved use of available time and the ability to schedule more cases. This alternative would also provide the data upon which to base distribution of operating time among the services.

Manually calculating the statistics required for this system would be extremely time-consuming and would require manpower dedicated to that function on a permanent basis. All calculations would have to be manually updated as each day's data is collected. As the literature has pointed out, there could also be physician resentment to being timed at how long they take in surgery. This alternative also affords no means for collecting anesthesia data and assisting in retrospective anesthesia audits.

The third alternative is to computerize the scheduling system. The computer would permanently store all data required to schedule operating time and perform all necessary statistical calculations. It

would only require someone to spend a short time each day entering that day's data.

A computerized system would also have the capability to support anesthesia research and retrospective anesthesia audits, as well as provide the means for equitably distributing operating time among the services.

A major disadvantage of this alternative would also be physician opposition to having their operating times scrutinized. Another disadvantage would be one inherent to all mechanical systems, that being possible mechanical failure. If any part of the equipment breaks down, the scheduling system would become nonfunctional.

II. DISCUSSION

Data Evaluation

As has already been pointed out, the amount of accurate data available has limited the scope of statistical analysis that could be accomplished in this study. The degree of accuracy of some of the calculated means, standard deviations, and standard errors has also been affected. While increasing the number of observations would have enhanced the accuracy of some of the calculations, not having a sufficient number of observations for every surgical procedure does not invalidate the methods and processes followed in this study nor does it negate the fact that operating room scheduling problems do exist. For the purposes of this discussion, data evaluation will be limited to those procedures for which there were sufficient observations to be statistically significant.

The results of the data collection and analysis are at Appendices A through J. They are categorized by specialty. Of special interest in this study is the comparison of the calculated means to the service chiefs' estimates of the average procedure times.

2

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examples of sample
size confidence
intervals etc.
Where was
this discussed
in the
original PSP?
Additionally,
please define
w/ numerical
what you mean
by that sig

In many instances the chiefs were quite accurate and their estimates were very close to the calculated means or within one standard deviation of the means. In other cases, they were well outside the standard deviation in their estimates.

In General Surgery Service (Appendix A), all estimates for procedure times were near the mean or within the standard deviation. This is in sharp contrast to Gynecology Service (Appendix B), where several of the chief's estimates were outside the calculated standard deviation. For example, the chief estimated that it should take about $1\frac{1}{2}$ hours to perform a total abdominal hysterectomy. The data indicate that it takes $2\frac{1}{2}$ hours to perform the operation. The standard error of the mean is 28 minutes and the standard deviation is 31 minutes. If the operating room is scheduled based upon the chief's estimate, one could expect the procedure to run an hour or more beyond its scheduled time. This would cause all other cases scheduled for that room to be pushed back, with one or two cases even being cancelled.

The scheduling system at Tripler is such that a physician could schedule four of these procedures in one day, stating that it would only take $1\frac{1}{2}$ hours

*impossible?
what is it?*

to perform each one. The anesthesiologist, not having any information with which to refute this estimate approves the schedule. It then turns out that the physician actually performs at the calculated mean of $2\frac{1}{2}$ hours per procedure. Not only would this mean exceeding the scheduled operating day, but it would also mean other cases scheduled for that room would have to be cancelled, not to mention the inconvenience to the patients and staff as a result of the backlog.

The data suggest that this same scenario could occur with several other procedures in the Gynecology Service, such as the total vaginal hysterectomy and the TAH with BSO. It also appears from the data that several procedures in Orthopedics Service (Appendix C) could produce a similar situation, such as the lumbar laminectomy and the total knee replacement. In these cases, the chief's estimates are also outside the standard deviations calculated for these procedures. The same is true concerning the vasovasectomy and TURBT procedures in Urology Service (Appendix D).

In addition, the data evaluation shows that other services such as Otolaryngology (Appendix E), Ophthalmology (Appendix F), and Obstetrics (Appendix G)

have Chief's estimates which are just barely within the standard deviations. If these procedures were to be scheduled according to the chiefs' estimates, operating room schedules would also suffer delays or periods of idle time.

The data evaluation served to reinforce the contention that the current system is less than efficient in scheduling surgery. This has been shown by the comparative analysis of the calculated procedure times and the service chiefs' estimated procedure times. Just as important, however, is the fact that the processes utilized in compiling these data actually established a manual system for data collection. Having procedures established for data collection is essential to the development of either a manual or a mechanical scheduling system.

In this regard, the research design designated the major source document for data collection, the DA Form 4107. It selected the information to be collected, which included anesthesia start and stop times by procedure, procedure start and stop times by both procedure and physician, the names of both the procedures and the physicians, and the service chiefs'

procedure time estimates. It also established the types of statistical analyses to be performed. These included: Calculating the mean and standard deviation for the anesthesia times by procedure and calculating the mean, standard deviation, and standard error for procedure times by both procedure and physician. As already mentioned, procedure times by physician do not appear in this study because there was not enough data to provide for a meaningful analysis. However, the available data was collected, thereby establishing the process for the future collection of this data, and the development of a more "personalized" scheduling system.

Systems Comparison

In order to determine the best scheduling system for Tripler, comparisons of Tripler's system with those of three area hospitals were made. In general, it was discovered that all three hospitals had variations of Tripler's system, or Tripler had a variation of theirs, but that none offered much in the way of innovations which would be worthwhile incorporating into Tripler's system.

St. Francis Hospital uses a ledger to schedule its surgical cases up to a year in advance. Some lulls were experienced in the daily schedule due to surgical complications and errors in estimating procedure times. However,

both the operating room staff and the physicians have been around for so long, some for over thirty years, that time estimating errors were minimal.²¹ There is no block booking at St. Francis and, although some operating rooms are equipped for certain procedures, all rooms are scheduled on a first-come, first-served basis. If an emergency arises and a specially equipped room is required, the schedule is adjusted accordingly.

At the Queen's Medical Center, scheduling is accomplished by using the combination of a ledger book and scheduling board and schedules are made up to two months in advance. Neither of these in any way contributes to estimating how long a physician will take to perform a certain procedure. Here, again, the staff and the majority of physicians have been there for so long that the experience factor is counted on to minimize errors in time estimates.²² The Queen's Medical Center also uses a first-come, first-served method for scheduling operating rooms.

The Straub Clinic and Hospital does utilize a block booking system like Tripler's and schedules surgical cases in a ledger up to a year in advance. The story here is the same as at the other hospitals with regard to estimating times. The staff and physicians have been there

for a long time. The person scheduling the surgical cases has been there over twenty years.²³

All three of these hospitals have scheduling systems which contain one important ingredient lacking in Tripler's system. That ingredient is an "institutional memory." The civilian hospitals can all count on the longevity and experience of their employees, their "institutional memories," to accurately estimate the length of time physicians will take for each procedure. Unfortunately, the constant personnel turbulence in the military does not afford Tripler this luxury. Because there is no one to serve as the "institutional memory," something is needed to fulfill that function.

Alternative Analysis

As previously introduced, the first alternative is to retain the present system in its present form, and wait for the new construction to be completed, hoping that a new operating theatre will resolve the current scheduling problems. The current system has no unknowns, and everyone is familiar with it. Surgery is being accomplished, and the operating rooms are fully scheduled every day. Here is where the advantages end.

This alternative does not offer any viable solution to the current scheduling problem other than the hope that a mere change in the physical plant will cause the problem to resolve itself. Even a new plant is more than three years into the future. This alternative provides no solution to the increasing demand for operating room time, and the anesthesiologists report that physicians are scheduling cases after hours and on weekends, and calling them emergencies, in order to get time in the operating room.

The problem of equitably distributing operating time among the various specialties is also left unresolved by this alternative. In addition, this system does not satisfy the other criteria described earlier in this study. There is no method for collecting anesthesia data nor is there any means to facilitate the conduction of retrospective anesthesia audits.

The second alternative is to maintain the present system of block booking, but to augment it with a manually prepared statistical analysis of selected data like that appearing in the Appendices of this study. This alternative would require that one person be assigned the duty of collecting all DA Forms 4107 and continually revise and update the data base by following the research design in this study. As new physicians and procedures arrive at Tripler, a data base would

have to be constructed for them. It would involve a considerable undertaking, as data would have to be collected and calculated for every procedure and surgeon at Tripler. The result would be a chart containing the various procedure and anesthesia times that the anesthesiologist would use as a guide for scheduling surgery.

This alternative would assist in minimizing the over- and under-scheduling of the operating rooms, because it would use a statistical basis for the scheduling, which is much more accurate than the current time-negotiating system. Other advantages attributable to this alternative would include the fact that it would facilitate scheduling by establishing a basis for determining procedure times, and it would provide the mechanism with which to maximize the number of cases performed. In addition, it would make available the data needed to more equitably distribute operating time among the services.

See next page

One disadvantage of this alternative is the fact that it would be labor intensive. Data on the twenty-five or more cases performed each day would have to be manually collected and added to the data base. All statistical charts would have to be updated manually and continuously reprinted in order to provide the latest, most accurate

scheduling data.

Another disadvantage to this alternative would be the possibility of physician resentment at having their procedure times published and compared with those of their colleagues. Yet another disadvantage would be that, while the data to equitably distribute operating time is available, it is not provided in any usable form. Additional calculations would have to be performed in order to ascertain service utilization patterns and effect equitable distribution of available operating room time.

*Is this an
adv or
disadvantage
On page 2?
you list it
as adv.*

Finally, this alternative would offer no means for collecting and retrieving pertinent anesthesia data. It, thus, would provide no avenue for conducting retrospective anesthesia audits.

The third alternative maintains the block booking concept and calls for computerizing the entire scheduling system. The computer program would assign codes to each procedure and surgeon. The data base would be constructed from the information on DA Form 4107, unless the systems analysts should decide to design a new form for this purpose. The program would be an open-ended one so that information could be continuously added to the data base. CRT's would be available in the operating room, making

scheduling virtually instantaneous. As soon as a physician brings in a surgery request, the anesthesiologist would enter the appropriate codes into the computer and the anesthesia time, procedure time for that particular physician, and the procedure time for all similar cases performed at Tripler would appear on the screen. There would no longer be a need for time negotiating, as the computer would indicate how long that particular physician would take to do that case.

The program would also be designed to provide other pertinent data. Entering the proper codes would produce a recapitulation of operating room time by service.

It would indicate which services are using all of their allotted time and which ones aren't. This would provide the data for ascertaining utilization patterns and for determining equitable distribution of available operating room time among the services.

This alternative would not be labor intensive, as no calculating would need to be done manually. The computer would do it all. The only requirement would be for someone to enter the data into the system on a daily basis. Personnel are already available to perform that function as it would only take one to two hours each day.

Documented?

The accurate and instantaneous scheduling would provide the capability to maximize the number of cases performed daily, thereby minimizing the over- and under-scheduling of the operating rooms. The greater degree of control maintained over the amount of available operating room time provided by this computerized system would increase the time available to surgeons, and greatly reduce the possibility that they would not be eligible for board certification.

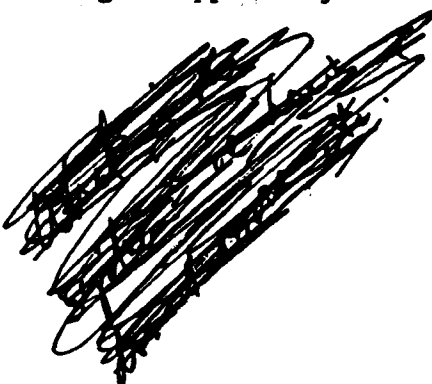
How?

The computerized system could also be designed to collect various types of anesthesia data. The types of drugs and equipment used, special procedures performed, and the listing of patient reactions and any complications could all be programmed into the system. Having this data available would allow the accomplishment of anesthesia research and retrospective anesthesia audits.

It is clear from the above discussion that the advantages to a computerized scheduling system in the operating theatre are many, and the benefits to the patients and staff great. However, there would also be some disadvantages which need to be reviewed. As has already been mentioned, physicians do sometimes resent having their times monitored, calculated, and compared.

While the computerized system would have limited accessibility and would not print data in hard copy, physician objections would need to be overcome. The literature does point out that this can be accomplished through demonstrating the system's benefits and usefulness.

The other disadvantage would be the fact that it is a mechanical system. Power or equipment failures could shut down the system. This problem could be overcome by reverting back to the present system temporarily. In any event, risking a system failure would be a small price to pay for the many advantages supplied by a computerized system.



III. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

It is concluded that the optimum solution to the problem of determining the best operating room scheduling system at Tripler is to computerize the scheduling system. As delineated in the discussion, the abundance of advantages favor a computerized scheduling system. A computerized system is the only solution that meets all of the criteria discussed earlier in this study. Even its disadvantages can be surmounted. There are no current resource constraints to developing, implementing, and using a computerized system.

As a result of this study and its conclusion, a number of actions have already been initiated. An initial systems request was written by this author on behalf of Doctor Bourke in order that Tripler's Automation Support Division could begin development of this system. A copy is at Appendix K. A computer feasibility study by Tripler's systems analyst has already been started.

On March 20, 1981, the Tripler Army Medical Center's Automation Advisory Group awarded this project the number one priority for development and implementation.

As a result of this action, a request has been sent to Health Services Command for approval of an Automatic Data Processing Class V System. A copy of this request is at Appendix L. According to the Chief of the Automation Support Division, approval is virtually automatic, and development of the system should not be hindered in any way.

In addition, the Anesthesiology Consultant to The Surgeon General has already asked Doctor Bourke for a copy of this study and research for implementation at Walter Reed Army Medical Center, and possible Army-wide application.

The system is being designed as an open-ended, random-access system. The first of its kind at Tripler. CRT's will be located in the anesthesiology office, where the scheduling will be accomplished. It is anticipated that this system will be on-line and fully operational by September 1981.

Recommendations

It is highly recommended that Tripler continue on its present course for developing, implementing, and operating a computerized operating room scheduling system as described in this study. It is further

recommended that DA Form 4107 continue to be saved until such time as the system is on-line, in order to provide a more substantial initial data base than one utilized for this study.

It is also recommended that the initial system only concern itself with anesthesia and procedure times, and the uses for this data. The ability to accept anesthesia information and provide anesthesia data for audits and research should be phased-in once the initial system has been debugged and become fully operational.

Finally, it is recommended that, once it is fully operational, this system be subjected to further study to determine its future value and applicability for use throughout the Army.

FOOTNOTES

¹Hunter A. Grumbles et al, "Simple, Equitable System Blends Flexibility with Firm Scheduling," Hospitals 51 (October 1, 1977), p. 95.

²John Kildea, "OR Scheduling Methods," Hospitals 44 (November 16, 1970), p. 99.

³Ibid., p. 101.

⁴Lewis Francis, "An Improved Method for Posting Surgery," AORN Journal 32 (September 1980), p. 490.

⁵Martha Hoffman, "A Graphic Look at OR Utilization," AORN Journal 22 (September 1975), p. 473.

⁶Kanella T. Phillips, "Operating Room Utilization," Hospital Topics 53 (March - April 1975), p.42.

⁷J. Goldman et al., "An Evaluation of Operating Room Scheduling Policies," Hospital Management 107 (April 1969), p. 41.

⁸Ibid., p. 42

⁹Dorothy M. Morgan, "Improved Scheduling Through Block Booking," Canadian Hospital 50 (February 1973), p. 41.

¹⁰Ibid.

¹¹Edward A. Ernst et al, "Operating Room Scheduling by Computer," Anesthesia and Analgesia 56 (November-December 1977), p. 831.

¹²Stephen L. Priest, "Computerized O.R. Log System has Many Uses," Hospitals 54 (June 1, 1980), p.82.

¹³Ibid.

¹⁴Ibid.

¹⁵John Cresto and Daniel Devor, "Surgical Suite: Computerize the Log." Hospitals 47 (July 1, 1973), p. 60.

¹⁶Michael J. Shaffer et al, "Manual Record-Keeping and Statistical Records for the Operating Room," Medical Instrumentation 12 (May-June 1978), p. 193.

¹⁷Ibid., p. 194.

¹⁸Priest, p. 81.

¹⁹Richard Bendix et al, "Computer Scheduling for the O.R.,"
Modern Health Care 5 (June 1976), p. 16n.

²⁰Ibid., p. 160.

²¹Interview with Irma Miller, Operating Room, St. Francis
Hospital, Honolulu, Hawaii, 2 December 1980.

²²Interview with Irene Scott, Operating Room, The
Queen's Medical Center, Honolulu, Hawaii, 30 December 1980.

²³Interview with Linda Bernard, Operating Room, Straub
Clinic and Hospital, Honolulu, Hawaii, 26 March 1981.

A P P E N D I X A

GENERAL SURGERY SERVICE DATA

10 SURGERY SERVICE

(Times in Hours: Minutes)

Procedure	Preparation Time		Production Time		Effective Estimate	Precedence
	Mean Standard Deviation		Mean Standard Deviation		Average	Standard Error
Reduction in complexity	4:05	41	3:29	1:00	4:00	1:00

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 permit fully legible reproduction

GYNECOLOGY SERVICE

(All Times in Hours: Minutes)

Procedure	Anesthesia Time		Procedure Time		Chief's Estimate	Procedure Time Standard Error
	Mean	Standard Deviation	Mean	Standard Deviation	Average	
D & C Fx	48	20	16	7	10	6
Cone Biopsy and D & C	1:09	19	35	11	30	9
Laparoscopy	1:05	13	29	2	30	2
Wertheim Hysterectomy	6:48	1:04	6:07	1:09	5:00	1:02
TAH/BSO w/Appendectomy	3:10	47	2:30	37	*	39
TAH/MMK w/Appendectomy	3:21	29	2:39	32	*	26
TAH w/Appendectomy	3:54	1:13	3:03	1:07	*	60
TVH and A & P Repair	3:25	57	2:32	53	2:00	49
Total Abdominal Hysterectomy	3:21	33	2:31	31	1:30	28
LTL w/F.R.	1:26	26	34	26	20	24
TAH & BSO	3:11	44	2:30	42	1:30	41
Total Vaginal Hysterectomy	2:08	30	1:25	25	55	21

* Data Not Submitted

APPENDIX B

GYNECOLOGY SERVICE DATA

GENERAL SURGERY SERVICE

(All Times in Hours: Minutes)

Procedure	Anesthesia Time		Procedure Time		Chief's Estimate	Procedure Time
	Mean	Standard Deviation	Mean	Standard Deviation	Average	Standard Error
Appendectomy	1:26	22	56	19	60	24
Cholecystectomy	2:15	37	1:32	35	90	34
Cholecystectomy w/IOC	2:35	49	1:57	39	90	45
Unilateral Inguinal Hernia Repair	1:27	35	51	25	*	25
Bilateral Inguinal Hernia Repair	1:38	27	1:15	38	*	32
Umbilical Hernia Repair	58	17	29	14	30	13
Carotid Endarterectomy	3:05	42	2:01	29	2:30	25
Perirectal Abscess	45	17	22	19	30	18

* Data Not Submitted

A P P E N D I X C

ORTHOPEDICS SERVICE DATA

ORTHOPEDICS SERVICE

(All Times in Hours: Minutes)

Procedure	Anesthesia Time		Procedure Time		Chief's Estimate	Procedure Time Standard Error
	Mean	Standard Deviation	Mean	Standard Deviation	Average	
Bunionectomy	2:13	38	1:11	32	1:30	27
Arthrotomy	1:57	26	1:02	32	60	28
Lumbar Laminectomy	3:32	10	2:11	33	1:30	27
Total Hip Replacement	5:55	1:14	4:01	44	4:00	36
URIF Ankle	3:16	44	2:28	48	1:30	42
Arthroscopy	1:34	34	45	17	60	16
Total Knee Replacement	4:49	24	3:21	21	4:00	18
Arthroscopy/ Arthrotomy	2:10	23	1:16	23	1:30	22

APPENDIX D

UROLOGY SERVICE DATA

UROLOGY SERVICE

(All Times in Hours: Minutes)

Procedure	Anesthesia Time		Procedure Time		Chief's Estimate	Procedure Time Standard Error
	Mean	Standard Deviation	Mean	Standard Deviation	Average	
Renal Biopsy	2:12	21	1:18	8	*	7
Vasovasostomy	2:39	22	2:02	23	3:00	20
Pyelolithotomy	3:11	35	1:59	35	1:30	32
TURP	2:20	42	1:33	35	1:30	33
High Ligation	1:31	22	52	12	45	12
TURBT	1:11	17	40	13	25	12
Hydrocelectomy	1:27	41	57	15	45	21

* Data Not Submitted

A P P E N D I X E

OTOLARYNGOLOGY SERVICE DATA

OTOLARYNGOLOGY SERVICE

(All Times in Hours: Minutes)

Procedure	Anesthesia Time		Procedure Time		Chief's Estimate	Procedure Time
	Mean	Standard Deviation	Mean	Standard Deviation	Average	Standard Error
Tonsillectomy	1:06	24	35	20	21	17
Myringotomy w/ P.E. Tube Insertion	41	22	14	8	6	10
Septoplasty	1:35	33	1:02	25	60	72
Septorhinoplasty	1:51	43	1:24	35	*	34
Direct Laryngoscopy	1:06	19	22	11	*	12
Tympanoplasty	3:23	24	2:17	38	*	32
Caldwell-Luc	1:42	30	1:12	20	*	25

* Data Not Submitted

APPENDIX F

OPHTHALMOLOGY SERVICE DATA

OPHTHALMOLOGY SERVICE

(All Times in Hours: Minutes)

Procedure	Anesthesia Time		Procedure Time		Chief's Estimate	Procedure Time Standard Error
	Mean	Standard Deviation	Mean	Standard Deviation	Average	
Cataract Extraction W/IOL	1:49	32	1:14	39	1:40	28
Cataract Extraction	1:33	29	58	25	1:15	24
Unilateral Recession-Resection	2:06	22	1:18	32	60	29

A P P E N D I X G

OBSTETRICS SERVICE DATA

OBSTETRICS SERVICE

(All Times in Hours: Minutes)

Procedure	Anesthesia Time		Procedure Time		Chief's Estimate	Procedure Time Standard Error
	Mean Standard Deviation		Mean Standard Deviation		Average	
Caesarian Section	1:22	25	56	20	35	21
Caesarian Section w/ Post-Partum Tubal Ligation	1:24	29	53	24	*	24
Post-Partum Tubal Ligation	53	23	25	11	20	12

* Data Not Submitted

A P P E N D I X H

ORAL SURGERY SERVICE DATA

ORAL SURGERY SERVICE

(All Times in Hours: Minutes)

Procedure	Anesthesia Time	Procedure Time	Chief's Estimate	Procedure Time Standard Error
	Mean Standard Deviation	Mean Standard Deviation	Average	
Le Fort I	5:11 1:02	4:01 45	4:00	39
Max-Mand Segmental Osteotomy	5:30 48	3:50 1:10	*	57

* Data Not Submitted

APPENDIX I

PLASTIC SURGERY SERVICE DATA

NEUROSURGERY SERVICE

(All Times in Hours: Minutes)

Procedure	Anesthesia Time		Procedure Time		Chief's Estimate	Procedure Time Standard Error
	Mean	Standard Deviation	Mean	Standard Deviation	Average	
Craniotomy for Tumor	5:59	3:40	4:05	3:37	4:00	3:12
Lumbar Laminectomy	2:55	1:16	2:01	1:02	1:30	1:08
Transphenoidal Adenomectomy	5:44	50	4:02	1:02	*	1:06
Cervical Disectomy	3:30	1:29	2:13	1:11	2:00	1:03

* Data Not Submitted

APPENDIX J

NEUROSURGERY SERVICE DATA

APPENDIX K

INITIAL SYSTEMS REQUEST

DISPOSITION FORM

For use of this form, see AR 340-13, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL

HST-DS-AD

SUBJECT

Initial Systems Request

THRU: ~~C, Dept of Surgery~~ *AD*

FROM C, Anes & Oper Svc

DATE 27 Jan 1981

CM 1

MAJ Bourke/jkt/7-5209

TO: C, Automation Management Division

1. In accordance with TAMC Suppl 1 to AR 18-1, the necessary information is provided in the prescribed format.

2. Requesting Agency: Anesthesia and Operative Service, Department of Surgery. Point of contact is MAJ Linda K. Weir, M.D., 433-5209.

3. There is no computer assistance of any kind in the present system. Scheduling is all accomplished manually, using personal experience as the only guide as to how long to schedule each procedure. Operating room requests are brought in by 0900 on the day before surgery is desired. The anesthesiologist then schedules use of all of the operating rooms based upon estimates of the time it will take that particular surgeon to perform that particular procedure. The objective of maximizing the use of available operation room time is not consistently achieved, as time estimates may not coincide with the actual procedure times.

4. The proposed system would provide computerized operating room scheduling. It would collect data with regard to anesthesia and operating times per procedure, and the physician's operating time per procedure. The names of the procedure and the physician, as well as the type of anesthesia utilized and any complications, would also be collected. The data would be entered on a continuous basis in order to provide the most accurate time estimate for a certain procedure being performed by a certain physician. The ultimate objective is to have a terminal in the operating room so that scheduling can be accomplished instantaneously.

5. The proposed system should be developed so that operating room scheduling can be accomplished more efficiently and timed properly and so that utilization of the operating rooms can be improved by doing the maximum number of cases in the time allotted. The system is also needed to facilitate retrospective anesthesia investigations and research. The problems of over- or under-scheduling operating rooms will be virtually eliminated.

6. The system assumes that similar cases are done similarly by the same surgeons. Except for emergencies, the operating room scheduling is limited to one 8-hour shift, five days a week.

7. There are no computer-supported systems in use in the operating room. Input data will be taken from the Operation Request and Worksheet (DA Form 4107) and the Register of Operations (DA Form 4108). These forms are attached as Inclosures 1 and 2. The output from this system would be used by the Department of Surgery for operating room scheduling, for monitoring operating room utilization, and for anesthesia research.

I thought this form was not "accurate". Why is it being used? Where are the forms?

SUBJECT: Initial Systems Request

8. This Service is not aware of any statutory or regulatory requirements which must be followed in the design and operation of the proposed system.

9. Workload Data:

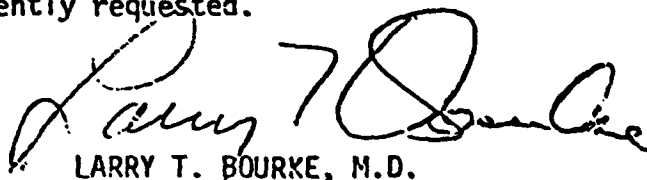
a. Input data would be submitted by surgical case and consist of: Anesthesia time, prep/setup time, operating (skin-to-skin) time, the type of procedure, the surgeon's name, and anesthesia data to include: equipment, drugs, techniques, and any complications. Tripler performs about 160 cases per week. Ideally, input would be made daily. Initially, weekly would be acceptable; monthly tolerable.

b. Output products would include operating time by both procedure and surgeon and total procedure time (anesthesia, prep/setup, and operating times). Again, this report would be needed on a daily basis, but initially, weekly would be acceptable and monthly tolerable. The anesthesia data report would be generated on an "as requested" basis.

10. Cost and manpower savings, while not itemized as yet, could prove to be substantial. Benefits will include a significant improvement in utilization of the operating theater, an increase in the caseload, a reduction in scheduling over-runs and idle time, and an immeasurable improvement in patient care. The operating room staff would also be utilized more efficiently with a computerized scheduling system.

11. Improved operating room scheduling is virtually impossible without computer support. Retrospective anesthesia research would be impossible. All the inefficiencies and inequities in the current system would continue unabated without this proposed computer system.

12. This system is needed as soon as possible. It was needed a year ago. Giving a top priority to this system is urgently requested.



LARRY T. BOURKE, M.D.

MAJ, MC

Chief, Anesthesia and Operative Service

A P P E N D I X L

REQUEST FOR APPROVAL
OF AUTOMATIC DATA PROCESSING
CLASS V SYSTEM



DEPARTMENT OF THE ARMY
HEADQUARTERS, TRIPLER ARMY MEDICAL CENTER
TRIPLER AMC, HAWAII 96859

REPLY TO
ATTENTION OF:

HST-IS

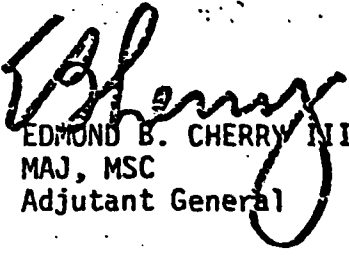
SUBJECT: Request for Approval of Automatic Data Processing Class V
System

Commander
US Army Health Services Command
ATTN: HSMS-M
Fort Sam Houston, TX 78234

1. Appendix W for the Operating Room Procedure System is forwarded for your approval.
2. Point of contact on this matter is Mr. Y. Fujita, 433-5269/5271.

FOR THE COMMANDER:

1 Incl
as


EDMOND B. CHERRY III
MAJ, MSC
Adjutant General

OPERATING ROOM PROCEDURE SYSTEM

1. Requesting Agency: Automation Support Division
Headquarters Tripler Army Medical Center
Tripler AMC, Hawaii 96859
Telephone: 808-433-5269
2. Data Processing Installation (DPI): H607
3. Proponent Agency: Same as Requesting Agency.
4. Description of Present System: Scheduling is all accomplished manually, using personal experience as the only guide as to how long to schedule each procedure. Operating room requests are brought in by 0900 on the day before surgery is desired. The anesthesiologist then schedules use of all of the operating rooms based upon estimates of the time it will take that particular surgeon to perform that particular procedure. The objective of maximizing the use of available operation room time is not consistently achieved, as time estimates may not coincide with the actual procedure times.
5. Description of Proposed System:
 - a. System Title: Operating Room Procedure System.
 - b. Hardware Configuration: Burroughs 1865, 512KB, 2 disk drives, 2 tape drives, printer, card punch and reader.
 - c. Location of Hardware: Bldg. 141, TAMC.
 - d. Language: COBOL.
 - e. System Description: The proposed system would collect data with regard to anesthesia and operating times per procedure, and the physician's operating time per procedure. The names of the procedure and the physician, as well as the type of anesthesia utilized and any complication, would also be collected. The data would be entered on a continuous basis in order to provide the most accurate time estimate for a certain procedure being performed by a certain physician. The ultimate objective is to have a terminal in the operating room so that scheduling can be accomplished instantaneously. Input data will be taken from the Operation Request and Worksheet (DA Form 4107) and the Register of Operations (DA Form 4108). The output from this system would be used by the Department of Surgery for operating room scheduling, for monitoring operating room utilization, and for anesthesia research.
6. Background: The proposed system should be developed so that operating room scheduling can be accomplished more efficiently and timed properly and so that utilization of the operating rooms can be improved by doing the maximum number of cases in the time allotted. The system is also needed to facilitate retrospective anesthesia investigations and research. The problems of over- or under-scheduling operating rooms will be virtually eliminated.

7. Assumptions/Restrictions: The system assumes that similar cases are done similarly by the same surgeons. Except for emergencies, the operating room scheduling is limited to one 8-hour shift, five days a week.

8. Security/Privacy Act Requirements: None.

9. Similar or Identical Systems: None.

10. Applications Interface: None.

11. Regulatory Requirements: None.

12. Workload Data:

a. Input: Input data would be submitted by surgical case and consist of: Anesthesia time, prep/setup time, operating (skin-to-skin) time, the type of procedure, the surgeon's name, and anesthesia data to include: equipment, drugs, techniques, and any complications. Tripler performs about 160 cases per week. Ideally, input would be made daily. Initially weekly would be acceptable; monthly tolerable.

b. Output products would include operating time by both procedure and surgeon and total procedure time (anesthesia, prep/setup, and operating times). Again, this report would be needed on a daily basis, but initially, weekly would be acceptable and monthly tolerable. The anesthesia data report would be generated on an "as requested" basis.

c. Data Elements: None.

13. Desired Operational Date: As soon as possible.

14. Priority: Top Priority.

15. Cost Benefit Analysis:

a. COST:

DEVELOPMENT:

(1) Programming = 4 months @ \$11.64 per hour = \$7636.00

(2) Computer = 10 hours @ \$40.00 per hour = \$400.00

TOTAL \$8036.00

PRODUCTION:

(1) Computer = 30 minutes daily = \$5200.00 annually

b. BENEFITS: Cost and manpower savings, while not itemized as yet, could prove to be substantial. Benefits will include a significant improvement in utilization of the operating theater, an increase in the caseload, a reduction in scheduling over-runs and idle time, and an immeasurable improvement in patient care. The operating room staff would also be utilized more efficiently with a computerized scheduling system.

16. Statement of Impact if System is not Approved: Improved operating room scheduling is virtually impossible without computer support. Retrospective anesthesia research would be impossible. All the inefficiencies and inequities in the current system would continue unabated without this proposed computer system.

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